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(71) Applicant(s)
Stephen Eric Rolfe
4 Leamington Rd, SOUTHEND-ON-SEA,
Essex, SS1 2SN, United Kingdom

(72) Inventor(s)
Stephen Eric Rolfe

(74) Agent and/or Address for Service
Sanderson & Co
34 East Stockwell Street, COLCHESTER,
Essex, CO1 1ST, United Kingdom

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(54) Abstract Title
Folding hollow constructional element for receipt of filler material

(57) A constructional element (10) for use in building a structure, is formed from a strip of flexible material (11) having four transverse hinge lines (12, 13, 14, 15). The strip may be folded to lie flat or erected by folding along the hinge lines to form four walls (15, 17, 18, 19) defining an essentially cuboidal cavity (32) having an open top and an open bottom. Slots (22, 24) are provided in walls (17, 19) of the element extending from one edge of the wall towards the opposed edge of the wall. In use, one such element may be linked with another like element by receiving two opposed walls of the other like element in the slots of the one element.

Figure 2

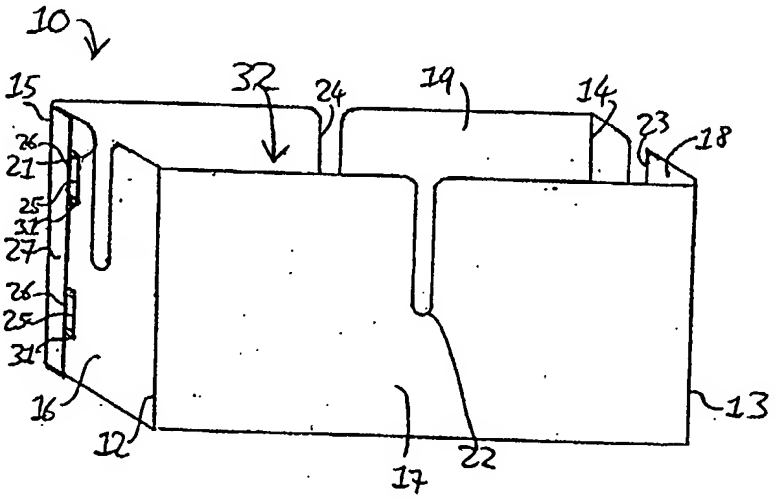

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Fig. 1

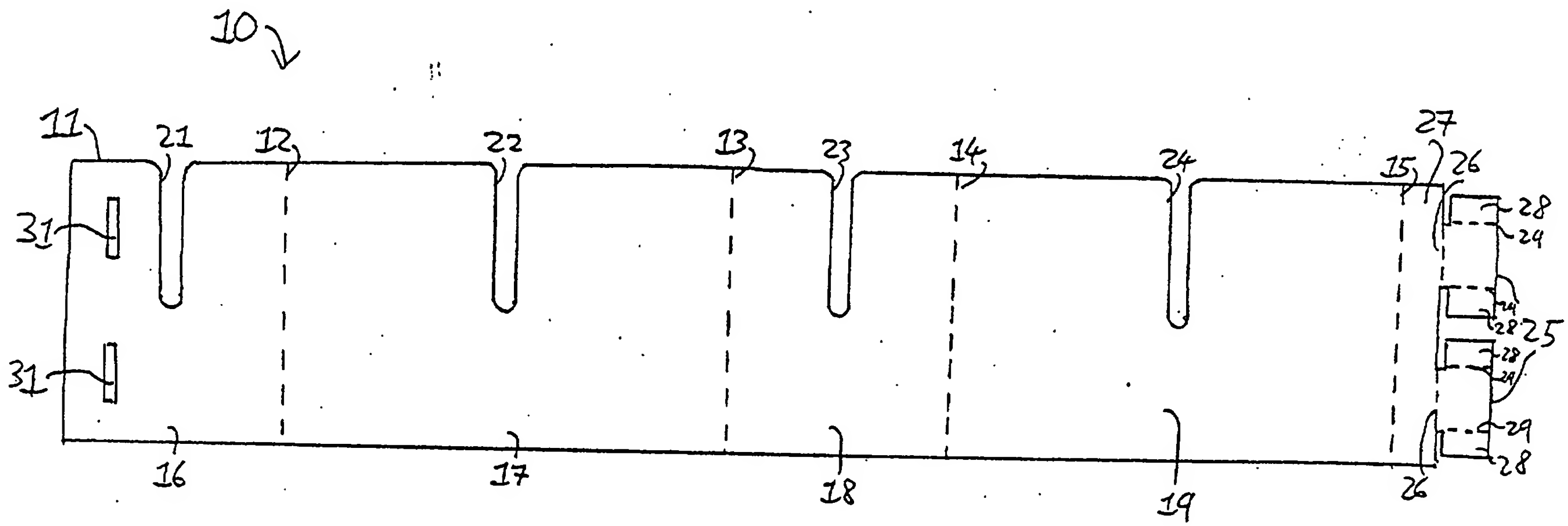


Figure 2

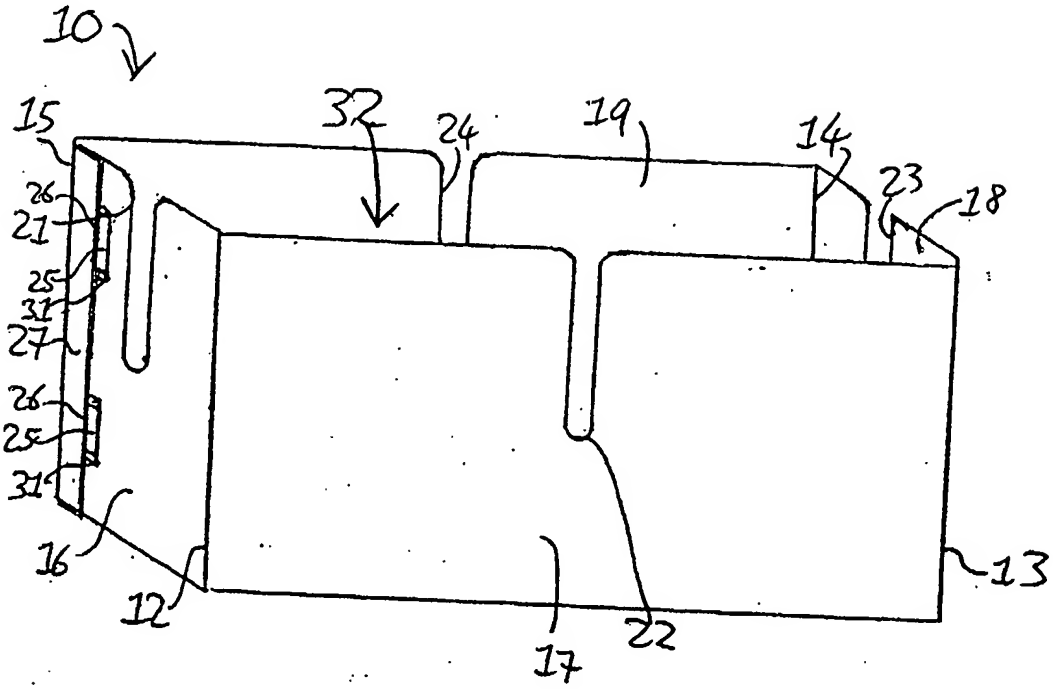


Figure 3a

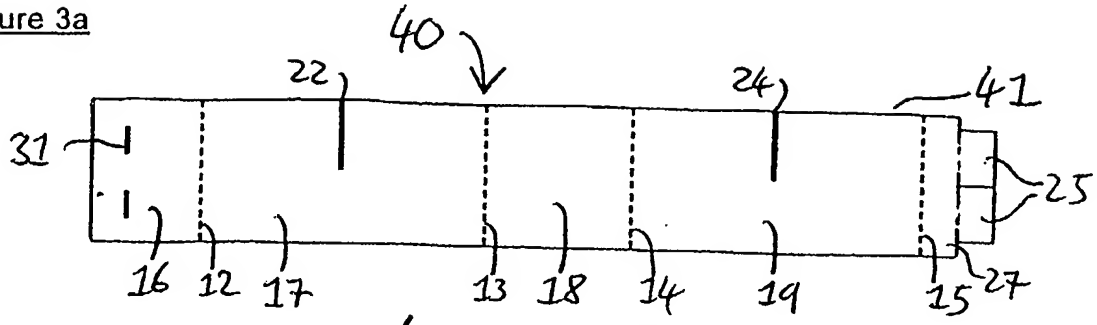


Figure 3b

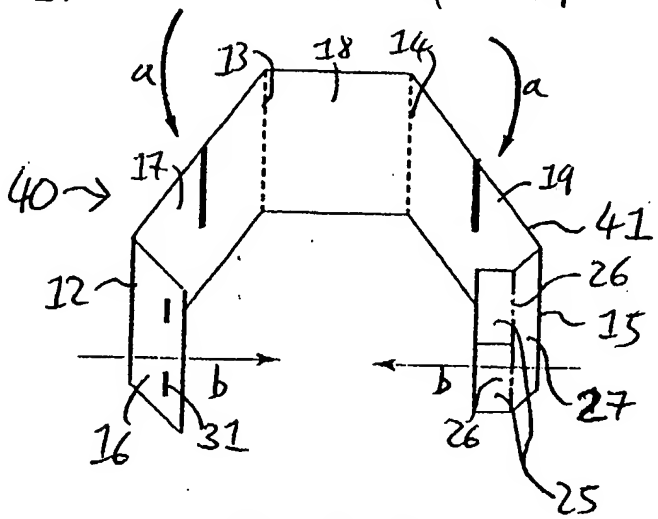


Figure 3c

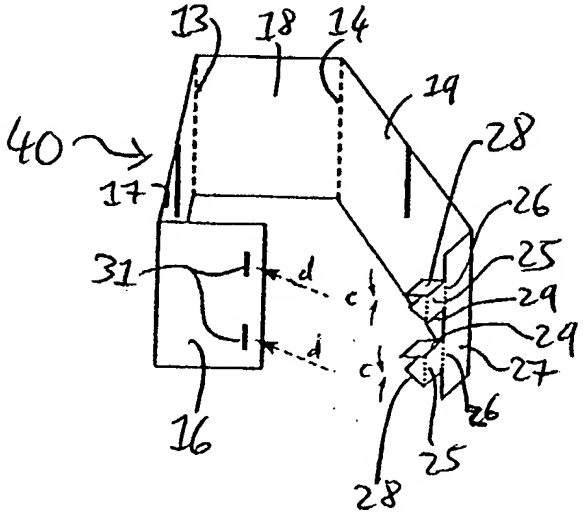


Figure 3d

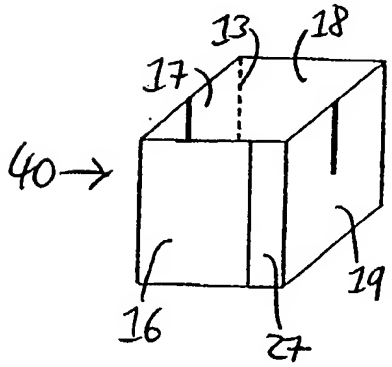


Figure 4

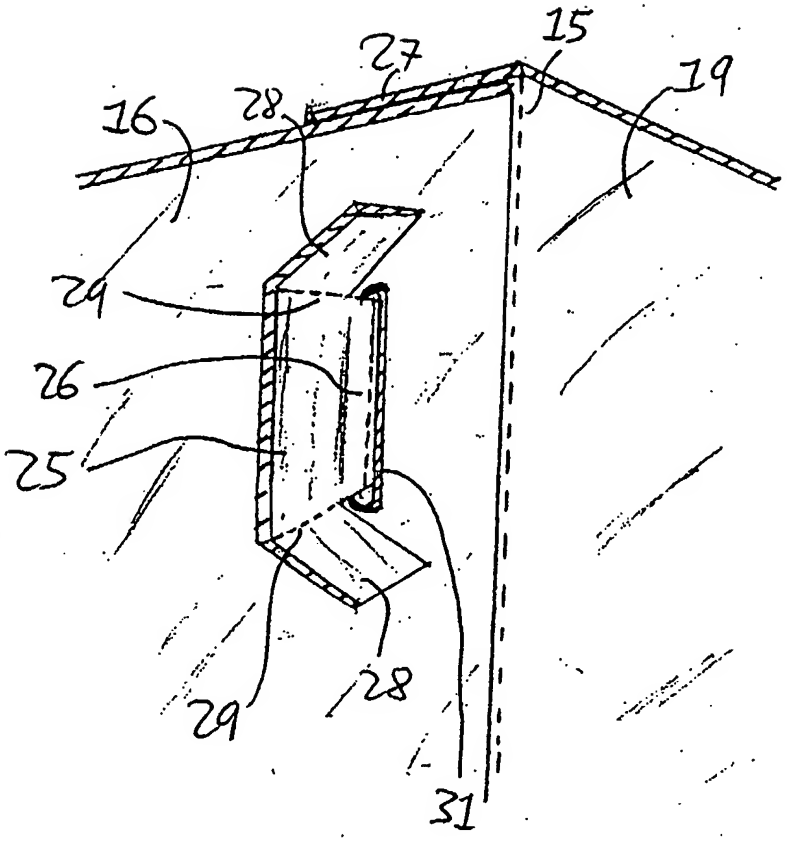


Figure 5

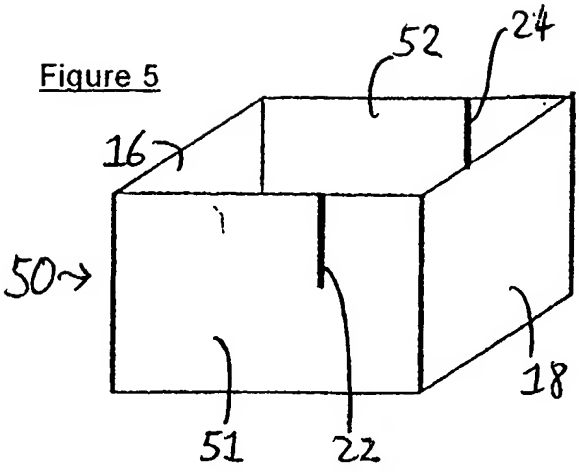


Figure 6

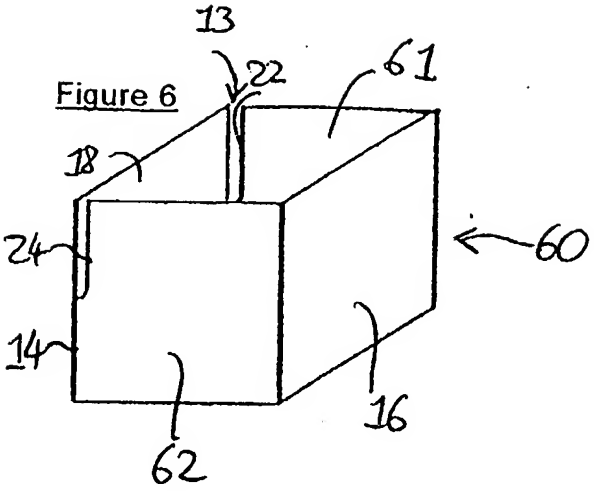


Figure 7

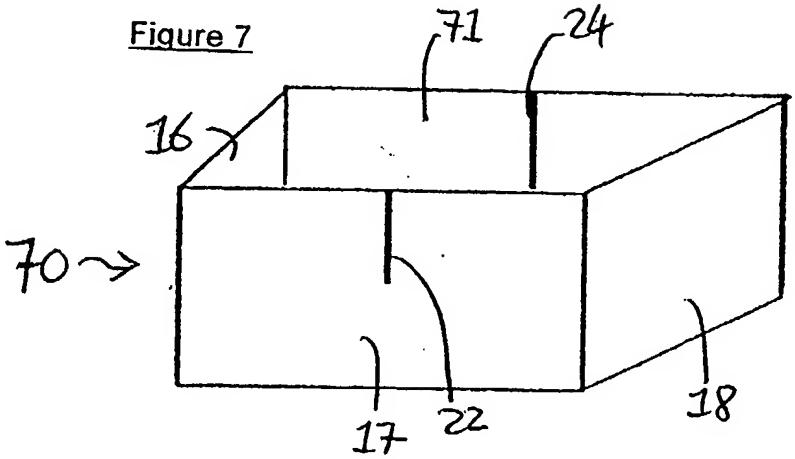


Figure 8

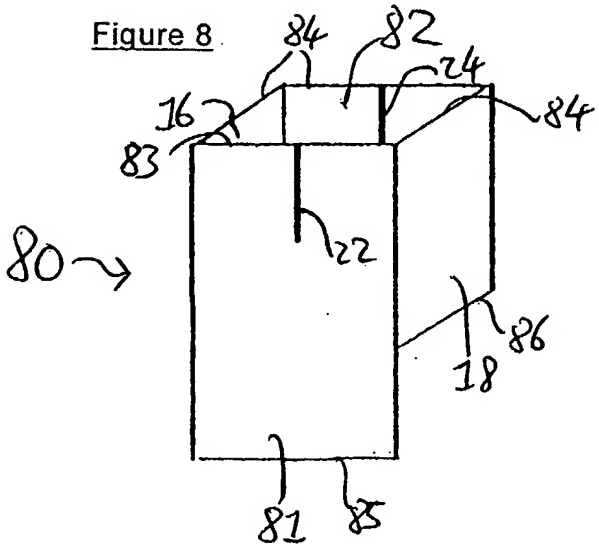
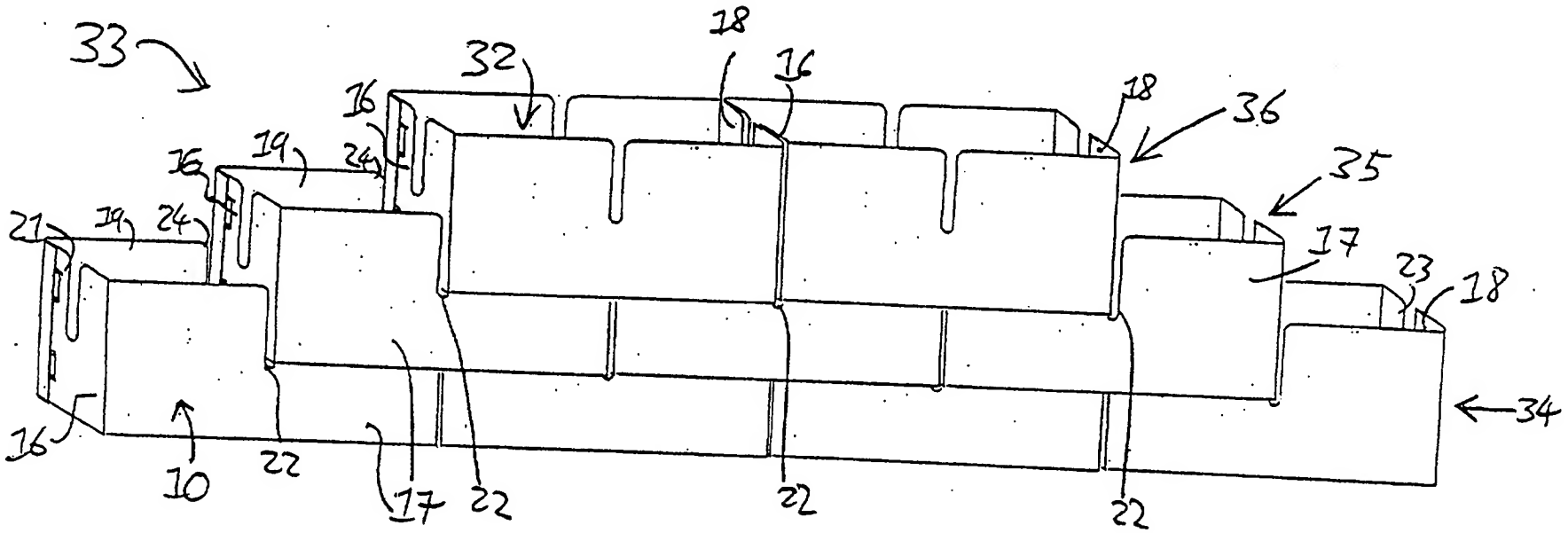


Figure 9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Folding Constructional Element

This invention relates to a folding constructional element, and to methods of building structures using a plurality of such elements linked together.

The invention has been developed primarily for use in the building of temporary shelters and flood defences, and therefore will be described herein with particular reference to these uses, although it is envisaged that it will also find use in many other applications, such as firewalls, sea defences, and other applications where temporary structures are required. The term "structure" is used herein to refer to any building, wall, or shelter.

The building of temporary structures, for example following a natural disaster such as an earthquake or flood, requires constructional components which can be easily and rapidly assembled, and which can be produced at low cost. They must be of a lightweight and convenient form which enables them to be easily and inexpensively transported to the area in need of relief, and yet a structure built therefrom must have adequate strength for its purpose.

Of the wide range of constructional components currently available, it is believed that none adequately addresses all of these needs simultaneously.

It has now been realised that all of the above objectives may be attained by providing folding constructional elements which are capable of conversion between a flat-packed un-erected form, and a

three-dimensional erected form having cavities capable of being filled with any suitable locally-available in-fill material such as sand or other aggregates. In an emergency situation such as the aftermath of an earthquake, it is envisaged that even the debris or rubble resulting from the disaster itself may be used as in-fill material. The building elements can thus be stacked in their flat-packed form for economically efficient storage and transportation.

According to one aspect of the present invention there is provided a constructional element for use in building a structure, which element is formed from a strip of flexible material having four transverse hinge lines whereby the strip may be folded to lie flat or erected to form four walls defining an essentially cuboidal cavity having an open top and an open bottom, at least two opposed walls of the element being provided with a respective slot extending from an edge of the wall towards the opposed edge of the wall, whereby one such element may be linked with another like element with two opposed walls of the other element being received in the slots of the one element.

The constructional element of the present invention may be formed from an endless strip, such that when the element is folded to lie flat, two adjacent walls overlie the other two adjacent walls. However, it is currently preferred that the constructional element is formed from a strip having two ends which are formed to permit the

inter-engagement thereof, whereby the ends of the strip may be joined together when the element is to be erected ready for use.

The transverse hinge lines are spaced along the length of the strip so as to define walls which, when the element is erected, form a pair of opposed side walls and a pair of opposed end walls, thus defining the cuboidal cavity.

In one embodiment of folding constructional element according to the present invention, the side walls are substantially twice the length of the end walls, and both walls of a pair are substantially the same length. In alternative embodiments, the side walls may be substantially one and a half times the length of the end walls, thus creating a three-quarter length block, or the side walls and the end walls may be substantially the same length, thus creating a half-length block. In still further alternative embodiments, the opposed side walls of a pair may be unequal in length, thus creating a substantially trapezium-shaped block.

When using the folding constructional elements of the present invention to build a structure, it is envisaged that two or more of these different embodiments may be used in combination for the construction of a single structure.

The inter-engagement of the two ends of the strip is preferably effected by the provision of one or more tabs at one end of the strip, and one or more complementary slits at the other end of the strip. The

element is thus erected by folding the strip along the hinge lines and inserting the tabs into the slits.

It is currently preferred that the constructional element has two such tabs spaced transversely across one end of the strip, and two complementary slits spaced transversely across the other end of the strip.

Slots for linking the constructional element with other like elements are provided in at least two opposed walls, preferably the side walls, and in an alternative embodiment may be provided in each wall of the constructional element. Preferably, the slots extend centrally from an edge of the wall towards the opposed edge of the wall for substantially one half of the height of the wall. The slots may be of any shape so as to perform their function in engaging the walls of a like element. However, it is currently preferred that they are generally of an elongated U-shape.

The constructional element may be formed from any flexible material. A degree of flexibility is essential to permit elements of identical size to be linked together, as some flexing of the walls must occur. In order to achieve this necessary flexibility, whilst also imparting the required strength to any structure built using the elements, it is currently preferred that the constructional element of the present invention is formed from flexible plastics material. Polycarbonate or polypropylene are the most preferred materials. It is

further preferred that the flexible plastics material is of a fluted double board construction.

In order that the constructional elements of the present invention may conform to required safety standards, it is most preferred that they be constructed from, or treated with, a substantially fire-proof or fire-retardant material.

The constructional elements may be of any convenient size, depending on the structure to be built. It is currently preferred that the standard elements be supplied in a "breeze-block" size, which when erected has a length of substantially 380 mm, a width of substantially 190 mm, and a height of substantially 240 mm. Alternatively, the elements may be supplied in a smaller size, which when erected has a length of substantially 200 mm, a width of substantially 100 mm, and a height of substantially 200 mm. The corresponding three-quarter length blocks are therefore supplied in a size which when erected has a length of substantially 285 or 150 mm, whilst the half-length blocks have a length of substantially 190 or 100 mm. The thickness of the strip is preferably in the range of from 2 to 4 mm.

In a further embodiment of folding constructional element according to the present invention, one of the side walls has a greater height than the other three walls. Whilst the extended side wall may project both above and below the edges of the other walls, it is preferred that one edge of the extended wall is aligned with the edges of the other three walls, whilst the opposed edge projects beyond the

opposed edges of the other walls.

This embodiment can be used for example to build a structure wherein a greater portion of each element is overlapped by the element immediately thereabove, thus imparting a greater water resistance to a structure. This embodiment may also serve as a tile block for use in roof construction. The preferred dimensions of the tile block are a length of substantially 200 mm, and a width of substantially 100 mm. The extended side wall has a height of substantially 330 mm, whilst the other three walls have a height of substantially 200 mm.

Another major aspect of the present invention provides a method of building a structure using a plurality of constructional elements of this invention as described above, each of which elements is erected to define a respective cavity, wherein a row of the erected elements is assembled on a supporting surface by placing the elements end-to-end, a second row of the elements is formed by locating the lower edges of the walls of further elements in the slots of the elements of the first row thereof, and in-fill material is deposited within the cavities defined by the co-operation of the elements.

The in-fill material may desirably be an aggregate, and for considerations of cost and availability, sand is currently the most preferred material. In emergency situations, any locally-available building debris or rubble may be used as the in-fill material.

When using constructional elements of the embodiment having

slots in all four of their walls, the method of building may comprise a further step of reinforcing the structure by inserting a rigid rod through the slots in adjoining walls of adjacent erected elements when the elements are placed adjacent to one another to form a row. The slots in two of the opposed walls are thus used to link like elements together, whilst the slots in the other two opposed walls accommodate the reinforcing rod.

In order to confer the optimum stability to the resultant structure, it is preferred that the elements should be combined in such a way that the lower edges of the end walls of one element are located in the slots in the side walls of two other elements arranged end-to-end to each other and located immediately below the one element.

When linked in this way, the length of the slots gives rise to a further advantage of the present invention. As the slots extend substantially half the height of their respective wall, when the constructional elements are linked in a staggered arrangement, the lower half of one element overlaps with the upper half of the elements beneath it, whilst its upper half overlaps with the lower half of the elements placed above it. The thickness of the material defining the cavity is therefore effectively doubled when the elements are combined in this way, thus imparting additional strength to the resultant structure.

The scope of the present invention extends to include a building constructed according to the above method using a plurality of

constructional elements as hereinbefore described.

In order that the present invention may be better understood, specific embodiments will now be described in detail, though only by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a plan view of a constructional element according to a first embodiment of the present invention, folded to lie flat;

Figure 2 shows a perspective view of the constructional element of Figure 1, having been erected ready for use;

Figure 3 is a sequence of views showing the process of erecting a second embodiment of constructional element, ready for use;

Figure 4 shows a detailed view of the inter-engagement means which enable the embodiments of constructional element of Figures 1 to 3 to be erected;

Figure 5 shows a perspective view of a third embodiment of constructional element, erected ready for use;

Figure 6 shows a perspective view of a fourth embodiment of constructional element, erected ready for use;

Figure 7 shows a perspective view of a fifth embodiment of constructional element, erected ready for use;

Figure 8 shows a perspective view of a sixth embodiment of constructional element, erected ready for use; and

Figure 9 shows a perspective view of a plurality of the erected

constructional elements of Figures 1 and 2 linked to form a structure.

Wherever possible, like components have been given like reference numerals.

Referring first to Figure 1, there is shown a folding constructional element, generally indicated 10, formed from a generally rectangular strip 11, which is shown here folded to lie flat.

The strip 11, has four transverse hinge lines 12, 13, 14, 15 along which the strip 11 may be folded to erect the element 10 ready for use. Walls 16, 17, 18, 19, are defined by the hinge lines 12, 13, 14, 15, which walls form a pair of opposed end walls 16, 18, and a pair of opposed side walls 17, 19 when the element 10 is erected. In this first embodiment, the side walls 17, 19 are substantially twice the length of the end walls 16, 18 and both walls of a pair are substantially the same length.

Each wall 16, 17, 18, 19 is provided with a respective slot 21, 22, 23, 24, whereby the element 10, may be linked with other like elements to build a structure. Each slot 21, 22, 23, 24 is located centrally along the length of its respective wall 16, 17, 18, 19, and extends for substantially half of the height of that wall.

One end of the strip 11 is provided with tabs 25, attached along tab hinge lines 26, to a flap 27 which in turn is attached along hinge line 15 to side wall 19. The tabs 25 are provided with laterally extending flanges 28, hingedly attached thereto along flange hinge lines 29. The other end of the strip 11 is provided with complementary

slits 31 formed in the first end wall 16.

Referring now to Figure 2, there is shown the same element 10 once erected, ready for use. The walls 16, 17, 18, 19 now define a generally cuboidal cavity, generally indicated 32, having an open top and an open bottom. When thus erected, the flap 27 overlies a portion of the first end wall 16, and the tabs 25 are located in the slits 31.

Referring now to Figure 3a, there is shown a second embodiment of constructional element, generally indicated 40, formed from a generally rectangular strip 41. This embodiment is essentially identical to that shown in Figure 1, except that slots 22, 24 are provided in side walls 17, 19 only, and not in end walls 16, 18.

As is shown in Figure 3b, in order to erect the element 40, the strip 41 is folded inwards along hinge lines 12, 13, 14, 15, as indicated by arrows *a* and *b*. The tabs 25 on flap 27 are folded inwards along tab hinge lines 26, and the flanges 28 are folded inwards along flange hinge lines 29, as is best indicated by arrows *c* in Figure 3c.

The tabs 25 are then inserted into the complementary slits 31 provided in end wall 16, as indicated by arrows *d*, to make the erected element 40 ready for use, as shown in Figure 3d. After insertion, the flanges 28 are folded outwards so as to retain the tabs 25 within the slits 31.

As is best shown in Figure 4, the flap 27, which is attached to side wall 19 along hinge line 15, overlies a portion of end wall 16. The

tabs 25, pass through the slits 31 formed in the end wall 16. During insertion of the tabs 25 into the slits 31, the extending flanges 28 are folded inwards about flange hinge lines 29 to lie substantially flat against the tabs 25. Once the tabs 25 have been inserted into slits 31, the flanges 28 may then be folded outwards from the tabs 25 along hinge lines 29, thus preventing the tabs 25 from becoming accidentally disengaged from the slits 31.

Figures 5 to 8 show further alternative embodiments of constructional element according to the present invention, for use in combination with the first and second embodiments described above.

Referring first to Figure 5, there is shown a third embodiment of constructional element, generally indicated 50, erected ready for use. This embodiment is essentially identical to that shown in Figure 3d, except that the opposed side walls 51, 52 are substantially one and a half times the length of the opposed end walls 16, 18. This creates a three-quarter length block, which is useful for the creation of junctions and openings in a structure to be built. The slots 22, 24 in this embodiment are located at substantially the same distance from the first end wall 16, as in the embodiments described above with reference to Figures 1 to 3, *i.e.* a distance equal to the length of the first end wall 16.

Referring now to Figure 6, this shows a fourth embodiment of constructional element, generally indicated 60. This embodiment is again essentially identical to that shown in Figure 3d, except that the

opposed side walls 61, 62 are substantially equal in length to the opposed end walls 16, 18, thus creating a half-length block, useful for placing at the end of a row of elements, or for forming junctions between adjacent rows. Again, the slots 22, 24 are located at substantially the same distance from the first end wall 16, which in this embodiment makes them co-incident with hinge lines 13, 14.

Referring now to Figure 7, there is shown a further embodiment of constructional element, generally indicated 70. In this embodiment, the first side wall 17 is of an identical length to the corresponding component in the first and second embodiments. However, the second opposed side wall 71 is greater in length, thus creating a substantially trapezium-shaped block, useful for the building of circular structures. The length of the second side wall 71 may be varied so as in turn to vary the angles between the end walls 16, 18 and the side walls 17,71.

Referring now to Figure 8, there is shown a still further embodiment of constructional element, generally indicated 80. in this embodiment, the side walls 81, 82 are substantially equal in length to the end walls 16, 18. However, the first side wall 81 has a greater height than the second side wall 82. As can be seen from Figure 8, the upper slot-bearing edge 83 of the first side wall 81, is aligned with the upper edges 84 of the other three walls 16, 18, 82. However, the lower edge 85 of the first side wall 81 projects below the lower edges 86 of the other three walls 16, 18, 82.

In use, this embodiment allows a greater portion of each element 80 to be overlapped by the extended side wall 81 of a like element immediately thereabove, thus providing the structure with greater resistance against the ingress of wind and water. For example, this embodiment 80 may be used as a tile block, in the construction of a flat or pitched roof for the structure being built. This would involve a plurality of like elements being interconnected such that the lower edges 86 of the end walls 16, 18 are received in the slots 22,24 of two like elements immediately below the first element 80. The extended side wall 81 would thus project downwards so as to cover a greater portion of the elements immediately therebelow.

Referring now to Figure 9, there is shown a plurality of erected constructional elements 10 linked together to form a structure, generally indicated 33. Although the elements shown here are of the first embodiment 10, it will be appreciated that the other alternate embodiments may be linked together in substantially the same way. A first row, generally indicated 34, of the erected elements 10 is assembled by placing the elements 10 end-to-end such that an end wall 16, 18 of one element is co-planar with an end wall 16, 18 of an adjacent like element. A second row, generally indicated 35, is then formed by locating a lower portion of the end walls 16, 18 of further like elements, in the slots 22, 24 provided in the side walls 17, 19 of the elements in the first row 34. In order that the elements 10 may be linked in this way, it is essential that they are formed from flexible

material, as the lower portion of the side walls 17, 19 of the elements in the second row 35 are required to flex outwards in order to accommodate the upper portion of the side walls 17, 19 of elements in the first row 34. This process may then be repeated to create a third row, generally indicated 36, and subsequent rows as desired.

The effect of the length of the slots 22, 24, which extend for substantially one half the height of their respective side walls 17, 19, is that when multiple elements 10 are linked as shown in Figure 9, the side walls 17, 19 of elements in the second row 35 overlap substantially the upper half of the side walls 17, 19 of elements in the first row 34, and in turn are overlapped by the lower half of the side walls 17, 19 of elements in the third row 36. In this way, the side walls of the communicating elements in the built structure are effectively doubled in thickness compared to the side walls 17, 19 in an unlinked erected element 10, thus enhancing the stability of the structure.

The respective cavities 32 of each element 10 then communicate with the cavities 32 of the elements immediately above and below them. In the preferred method of construction, the communicating cavities 32 are filled with sand to impart increased strength to the structure 33. The elements 10 are linked in such a way that the left half of the cavity 32 of an element in the second row 35, communicates with the right half of the cavity of an element immediately below it in the first row 34, and with the right half of the cavity of an element immediately above it in the third row 36.

The effect of this, when using elements whose side walls 17, 19 are substantially twice the length of their end walls 16, 18, is that when the thus-communicating cavities 32 are filled with sand, this creates pillars of sand of generally square cross-section, thus further enhancing the stability of the structure 33.

If desired, corners may be formed in the structure 33 by linking the elements 10 at right-angles (not shown) such that a side wall 17 or 19 of an element in the second row 35 is engaged by the slots 22, 24 in the side walls 17, 19 of an element in the first row 34.

Further stability may be added to the structure 33 by inserting reinforcing rods (not shown) into the communicating slots 21, 23 in the end walls 16, 18 of adjacent elements in the same row.

Alternatively, a structure 33 of double thickness (not shown) may be created by assembling a first row of erected elements 10 side-by-side such that the first side wall 17 of one element is co-planar with the second side wall 19 of an adjacent like element, and linking the elements with like elements in a second row by means of the slots 21, 23 in the end walls 16, 18.

Claims

1. A constructional element for use in building a structure, which element is formed from a strip of flexible material having four transverse hinge lines whereby the strip may be folded to lie flat or erected to form four walls defining an essentially cuboidal cavity having an open top and an open bottom, at least two opposed walls of the element being provided with a respective slot extending from an edge of the wall towards the opposed edge of the wall, whereby one such element may be linked with another like element with two opposed walls of the other element being received in the slots of the one element.

2. A constructional element as claimed in claim 1, wherein the strip is endless and when folded to lie flat has two adjacent walls overlying the other two adjacent walls.

3. A constructional element as claimed in claim 1, wherein the strip has two ends which are formed to permit the inter-engagement thereof, whereby the ends of the strip may be joined together when the strip is to be erected to define said cavity.

4. A constructional element as claimed in claim 3, wherein one end of the strip is provided with one or more tabs and the other end of the strip is provided with one or more complementary slits whereby the tabs may be inserted into the slits when the strip is erected.

5. A constructional element as claimed in claim 4, having two tabs spaced transversely across one end of the strip, and two

complementary slits spaced transversely across the other end of the strip.

6. A constructional element as claimed in either of claims 4 or 5, wherein the tabs are provided with laterally extending flanges hingedly attached thereto.

7. A constructional element as claimed in any of the preceding claims, wherein the transverse hinge lines are spaced along the length of the strip so as to define walls which, when the element is erected, form a pair of opposed side walls and a pair of opposed end walls, defining the cuboidal cavity.

8. A constructional element as claimed in claim 7, wherein both opposed walls of a pair are substantially the same length.

9. A constructional element as claimed in claim 8, wherein the side walls are substantially twice the length of the end walls.

10. A constructional element as claimed in claim 8, wherein the side walls are substantially one and half times the length of the end walls.

11. A constructional element as claimed in claim 8, wherein the side walls and the ends walls are substantially equal in length.

12. A constructional element as claimed in claim 7, wherein the opposed end walls are substantially the same length, and the opposed side walls are unequal in length.

13. A constructional element as claimed in any of claims 7 to 12, wherein one of the side walls has a greater height than the other three walls.

14. A constructional element as claimed in claim 13, wherein one edge of said extended side wall is aligned with the edges of the other three walls, whilst the opposed edge projects beyond the opposed edges of the other walls.

15. A constructional element as claimed in any of the preceding claims, wherein the slots extend centrally from an edge of a wall towards the opposed edge of the wall.

16. A constructional element as claimed in any of claims 1 to 14, wherein slots are provided in the opposed side walls.

17. A constructional element as claimed in claim 16, wherein the distance between at least one end wall and at least one slot provided in an adjacent side wall is equal to the length of the end wall.

18. A constructional element as claimed in any of the preceding claims, wherein the slots extend for substantially one half of the height of the wall.

19. A constructional element as claimed in any of the preceding claims, wherein a slot is provided in each of the four walls.

20. A constructional element as claimed in any of the preceding claims, wherein each slot is generally of an elongated U-shape

21. A constructional element as claimed in any of the preceding claims, formed from flexible plastics material.

22. A constructional element as claimed in claim 21, wherein the flexible plastics material is of a fluted board construction.

23. A constructional element as claimed in claim 21 or claim 22, wherein the flexible plastics material is polycarbonate or polypropylene.

24. A constructional element as claimed in any of claims 21 to 23, wherein the flexible plastics material is treated with a substantially fire-proof or fire-retardant material.

25. A constructional element as claimed in any of claims 1 to 22, formed from a substantially fire-proof or fire-retardant material.

26. A constructional element for use in building a structure, and substantially as hereinbefore described, with reference to and as illustrated in the accompanying drawings.

27. A method of building a structure using a plurality of constructional elements as claimed in any of the preceding claims, each of which elements are erected to define respective cavities, wherein a row of the erected elements is assembled on a supporting surface by placing the elements adjacent to one another, a second row of the elements is formed by locating the lower edges of the walls of further elements in the slots of the elements of the first row thereof, and in-fill material is deposited within the cavities defined by the co-operation of the elements.

28. A method as claimed in claim 27, wherein the in-fill material is an aggregate.

29. A method as claimed in claim 27 or claim 28, wherein the in-fill material is sand.

30. A method as claimed in claim 27 or claim 28, wherein the in-fill material is building debris or rubble.

31. A method of building a structure as claimed in any of claims 27 to 30, using elements having slots in each of their four walls, which method comprises a step of reinforcing the structure by inserting a rigid rod through the slots in adjoining walls of adjacent erected elements when the elements are placed adjacent to one another to form a row.

32. A method of building a structure as claimed in any of claims 27 to 31, wherein the elements are linked together such that the end walls of one element are located in slots in the side walls of two other like elements arranged end-to-end to each other and located immediately below the one element.

33. A structure built according to a method as claimed in any of claims 27 to 32.

34. A structure built using constructional elements as claimed in any of claims 1 to 26.

Application No: GB 0209570.1
Claims searched: 1 - 34

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): E1D: DLEG, DLEP, DLEJ

Int Cl (Ed.7): E04B

Other: ON - LINE: EPODOC, PAJ, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0206502 A SANDSLEEVE	1,2,7-9,11,15-17,20,27,32

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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